391.1 DESCRIPTION

This work consists of filling existing voids under PCC pavement by drilling injection holes and pumping a cement/fly ash grout under the pavement slab.

391.2 MATERIALS

A. Design Mix: The design mix for grout shall conform to the following proportions by absolute volume:

1 Part Portland cement
3 Parts fly ash
Water to achieve the specified fluidity

Fluidity of the grout when measured by a flow cone in accordance with ASTM C939 shall have a time of efflux between 9 and 15 seconds.

The Contractor shall submit for approval, materials proposed for use. The submittal shall include mill certification for cement, physical and chemical analysis for fly ash, and tests of the grout slurry by a Department approved testing laboratory. Tests shall show one, three, and seven day strengths, flow cone times, shrinkage and expansion observed, and time of initial set. The seven day strength shall be at least 600 psi (4.1 MPa) as measured in accordance with ASTM C942. As an alternate, standard 6 inch (152.4 mm) diameter by 12 inch (304.8 mm) high water tight concrete cylinder molds may be used to determine seven day strength. When the cylinder molds are used, the strength shall be 700 psi. (4.8 MPa) minimum.

B. Portland Cement: Type 1 or Type 2 cement shall be required, and the cement shall meet the requirements of Section 750.

C. Fly Ash: Fly ash shall conform to Section 753.

D. Water: Water shall conform to Section 790.

391.3 CONSTRUCTION REQUIREMENTS

A. General: The Contractor, or subcontractor performing the undersealing shall have prior experience with undersealing operations, and shall have personnel on the project with expertise in undersealing. Prior to awarding the contract, the Department may require the Contractor to substantiate previous experience with this type of work. The Contractor, upon Department request, shall be required to submit a list of at least three projects on which the Contractor or undersealing subcontractor has satisfactorily completed similar work.

Deflection testing of the joints shall be performed as required by the Engineer. Testing may be performed either before and or after the undersealing operation.

The Contractor shall take the necessary precautions to avoid slurry or foam from entering areas such as pipes, culverts, voids behind abutments or other such areas that may hinder the functionality of the roadway. If foam or slurry enters these areas, it shall be removed to the satisfaction of the Engineer at no additional expense to the State.

Jacking foam shall not be used for undersealing except as allowed as per Section 392.3.A.

B. Deflection Testing: The Contractor shall furnish either a deflection measuring device that can apply at least 8000 pounds (35.6 kN) of force (either vibrating or falling weight), or a loaded vehicle having a single axle that can be loaded to 18 kips (8200 kg) evenly distributed between the two sides to test joints and cracks.

1. If a deflection measuring device is used, the loading plate shall be placed as close as possible to the slab corner. Load transfer shall be measured with sensors that are placed adjacent to the joint or crack on the loaded and unloaded side.

2. If a loaded vehicle is used as a measuring device, a gauge mount shall be positioned with one gauge referenced to the corner of each slab on both sides of the joint near the shoulder edge perpendicular to the pavement joint. The gauges should then be zeroed with no load on the slab on either side of the joint. A loaded truck shall then be moved into position with the center of the 18 kip (8200 kg) axle one foot (300 mm) behind the joint and the outside test wheel one foot (300 mm) from the pavement edge, both gauges shall be read.

The loaded truck shall be moved across the joint to a position one foot (300 mm) past the joint and both gauges read again.

Deflection testing shall be performed when the slabs are not experiencing curl or joint closure. This normally takes place between midnight and 10:00 a.m. The Engineer may stop testing earlier if there is evidence of slab lockup due to thermal expansion of the slabs. The Engineer may allow the testing to continue after the hour specified, providing the slabs are not interlocked or under compression.

Upon completion of preliminary deflection testing of joints, the Engineer will determine the deflection range that warrants undersealing.

C. Weather and Seasonal Limitations: Grout undersealing shall not be performed when the pavement surface temperature is below 40° F (4° C), or if the subgrade or base course is frozen.

D. Equipment:

1. Grout Plant: The grout plant shall consist of a positive displacement cement injection pump and a high speed colloidal mixing machine. The colloidal mixing machine shall operate between 800 and 2000 RPM, creating a high shearing action and subsequent pressure release to make a homogeneous mixture

The injection pump shall have pressure capability from 250 to 300 psi (1.7 to 2.1 MPa) when pumping a grout slurry mixed to a 12 second flow cone time. The pump shall be capable of

continuous pumping at rates as low as 1.5 gallons (5.7 L) per minute or have the system modified by adding a recirculating hose and valve at the discharge of the pump.

2. **Drilling:** An air compressor and rock drills or other devices capable of drilling the injection holes through the pavement shall be required. The equipment shall be operated in such a manner that holes are vertical and not out of round. Holes shall be drilled in a manner that prevents breakout at the bottom of the pavement. The downward force of the drill shall not exceed 200 pounds (0.89 kN).

E. Drilling Holes: A hole pattern for grout injection will be determined by the Engineer in consultation with the Contractor. Variations from plans quantity will not be considered cause for renegotiation of the contract unit prices.

Holes shall be between 1.5 and 2 inches (38 and 50 mm) in diameter, drilled vertically and round, to a depth sufficient to penetrate any stabilized base and into the subgrade material. Subgrade penetration shall not exceed three inches (75 mm). Holes may be washed to create a small cavity, allowing initial spread of grout.

F. Subsealing: During subsealing operations, the upward movement of the pavement shall not exceed 0.125 inches (3 mm), unless otherwise allowed by the Engineer. The Contractor shall supply equipment to measure slab deflection and lift. This equipment shall be capable of detecting simultaneously the movement of the pavement edge or any two outside slab corners adjacent to a joint and the adjoining shoulder. The equipment shall have the capacity of accurately measuring to 0.001 inches (0.02 mm). Measurement devices to detect slab movement with respect to a stable reference point shall be subject to approval before use. Pavement that has been raised in excess of this amount may be subject to removal and replacement, or grinding to the correct grade, as determined by the Engineer.

An expanding rubber packer or other approved device connected to the discharge from the plant shall be lowered into the hole. The discharge end of the packer or hose shall not extend below the lower surface of the concrete pavement.

Each hole shall be pumped until maximum pressure is built up or material is observed flowing from hole to hole. Maximum pressure shall be 60 psi (0.4 MPa). A short surge up to 150 psi (1.0 MPa) will be allowed when starting to pump the hole. The pressure shall be monitored by a gauge in the grout line that is protected from the grout slurry.

Mixed material shall not be held in the mixer or injection sump pump for more than one hour after mixing. Any material held longer than one hour shall be wasted and will not be paid for. Additional water shall not be added after initial mixing of the grout.

Water displaced from the void structure by the grout shall be allowed to flow out freely. Excessive loss of the grout through cracks, joints, other drilled holes, or from back pressure in the hose or in the shoulder area will not be tolerated and will not be paid for.

If the Engineer determines that continued grout injection at a specific location is no longer feasible due to major voids he may direct the Contractor to cease grout injection at that location.

Upon completion of undersealing and prior to the injection grout drying on the sides of the drill holes, the drill holes shall be filled with a fast setting sand/cement mixture or other patch material approved by the Engineer. If the injection grout has dried on the sides of the drill holes, the sides of the drill holes shall be sand blasted and blown out prior to filling the holes with fast setting sand/cement mixture.

G. Radial Cracks: Cracks emanating radially from the grout injection holes will be presumed to have been caused by improper injection techniques by the Contractor. For each five linear feet (5 m) of crack measured, the pay quantity will be reduced by one cubic foot (0.1 cubic meter) of grout. As an alternative, the Engineer may require replacement of the damaged panel or a portion of the damaged panel, at the Contractor's expense.

H. Transverse Cracks: If cracks develop between adjacent grout injection holes, the Contractor shall repair the cracks by a satisfactory method approved by the Engineer. As an alternative, the Engineer may require replacement of the entire panel or a portion of a damaged panel at the Contractor's expense.

391.4 METHOD OF MEASUREMENT

A. PCC Drill Holes: The holes accepted will be measured per each. The holes drilled after the deflection testing will not be included for payment.

B. PCC Pavement Undersealing: Pavement undersealing will be measured to the nearest cubic foot (0.1 cubic meter). Portland cement will be the only material measured for payment. One bag of cement (94 Pounds) shall equal one cubic foot of PCC pavement undersealing (3½ bags of cement [42.64 kg per bag] shall equal 0.1 cubic meters of PCC pavement undersealing).

C. Deflection Testing: The test locations will be measured per each. Testing before and after undersealing at the same joint will be measured as separate locations.

If the deflection testing after undersealing is in excess of 0.010 inches (0.25 mm) further undersealing will be required.

Should the testing, after the undersealing is performed, indicate a need for further undersealing at that joint, all additional testing at that joint will be at no additional cost to the Department.

391.5 BASIS OF PAYMENT

A. PCC Drill Holes: The holes drilled will be paid for at the contract unit price per each. Payment will be full compensation for all materials, equipment, tools, and incidentals required to drill, plug and seal the holes after the undersealing is completed.

B. PCC Pavement Undersealing: Pavement undersealing will be paid for at the contract unit price per cubic foot (0.1 cubic meters). Payment will be full compensation for all materials, including fly ash and water, labor, equipment, tools, and incidentals required.

C. Deflection Testing: Testing will be paid for at the contract unit price per each test location. Payment will be full compensation for all materials, equipment, tools, and incidentals required.

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